

## Insights into electrical spin injection from spin-LED structures

B. T. Jonker,<sup>1</sup> Y. D. Park,<sup>1</sup> E. A. Hanbicki,<sup>1</sup> R. M. Stroud,<sup>1</sup> B. R. Bennett,<sup>1</sup> G. Itskos,<sup>2</sup> M. Furis,<sup>2</sup> G. Kioseoglou<sup>2</sup> and A. Petrou<sup>2</sup>

<sup>1</sup>Naval Research Laboratory  
4555 Overlook Avenue, SW  
Washington, DC 20375-5343  
USA

<sup>2</sup>State University of New York  
Department of Physics  
Buffalo, NY 14260  
USA

Recent results based on the concept of a spin-LED [1] have convincingly demonstrated the efficacy of electrical spin injection, where another semiconductor with a net carrier spin polarization is used as the injecting contact [2-4]. Spin polarized carriers electrically injected across an interface radiatively recombine in a quantum well "detector" and emit circularly polarized light. The quantum selection rules describing the process provide a model-independent, quantitative measure of the spin injection efficiency. We have obtained highly efficient spin injection into AlGaAs/GaAs and GaAs/InGaAs quantum well LEDs using the semimagnetic semiconductor ZnMnSe as the contact. We have used these simple structures to specifically address the role of parameters generic to a heterointerface on spin polarization, including dislocations, interface chemistry, potential steps and sub-monolayer impurities. We demonstrate that efficient spin injection can occur across even air-exposed interfaces, and that the individual components of the EL lineshape exhibit very different polarization, providing insight into spin relaxation mechanisms. Finally, we describe our results for other contact materials and alternate approaches to electrical spin injection.

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1. B. T. Jonker, US Patent 5,874,749 2. R. Fiederling, et. al., Nature, 402, 787 (1999) 3. Y. Ohno. et. al., ibid, 790 (1999). 4. B. T. Jonker, et. al., Phys. Rev. B, 62, 8180 (2000).